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(54) Abstract Title
UV dryer with shaped reflector surface

(57) A dryer, for drying printing inks and the like, including an elongated UV lamp 10 and a reflector housing which supports reflector surfaces 8 9 which are generally elliptical in section but depart from a true ellipsoid in an apex region 20 thereof so that all light reflected by the reflect surfaces passes outside the envelope of the UV lamp 10. The reflector surface may have moveable parts which are preferably pivotable. Control means may be included to adjust the surfaces if the speed of the web being treated changes. The UV lamp is preferably mounted on a carriage which is slidable into and out of its housing.

Fig 5

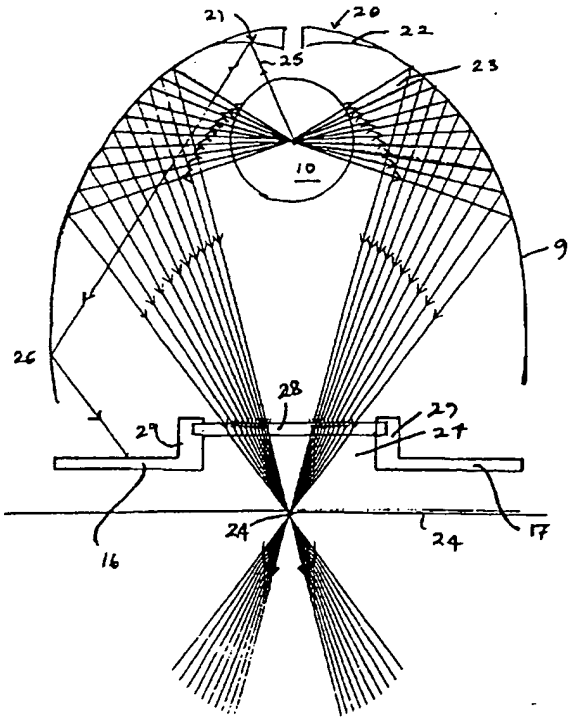

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Fig 1

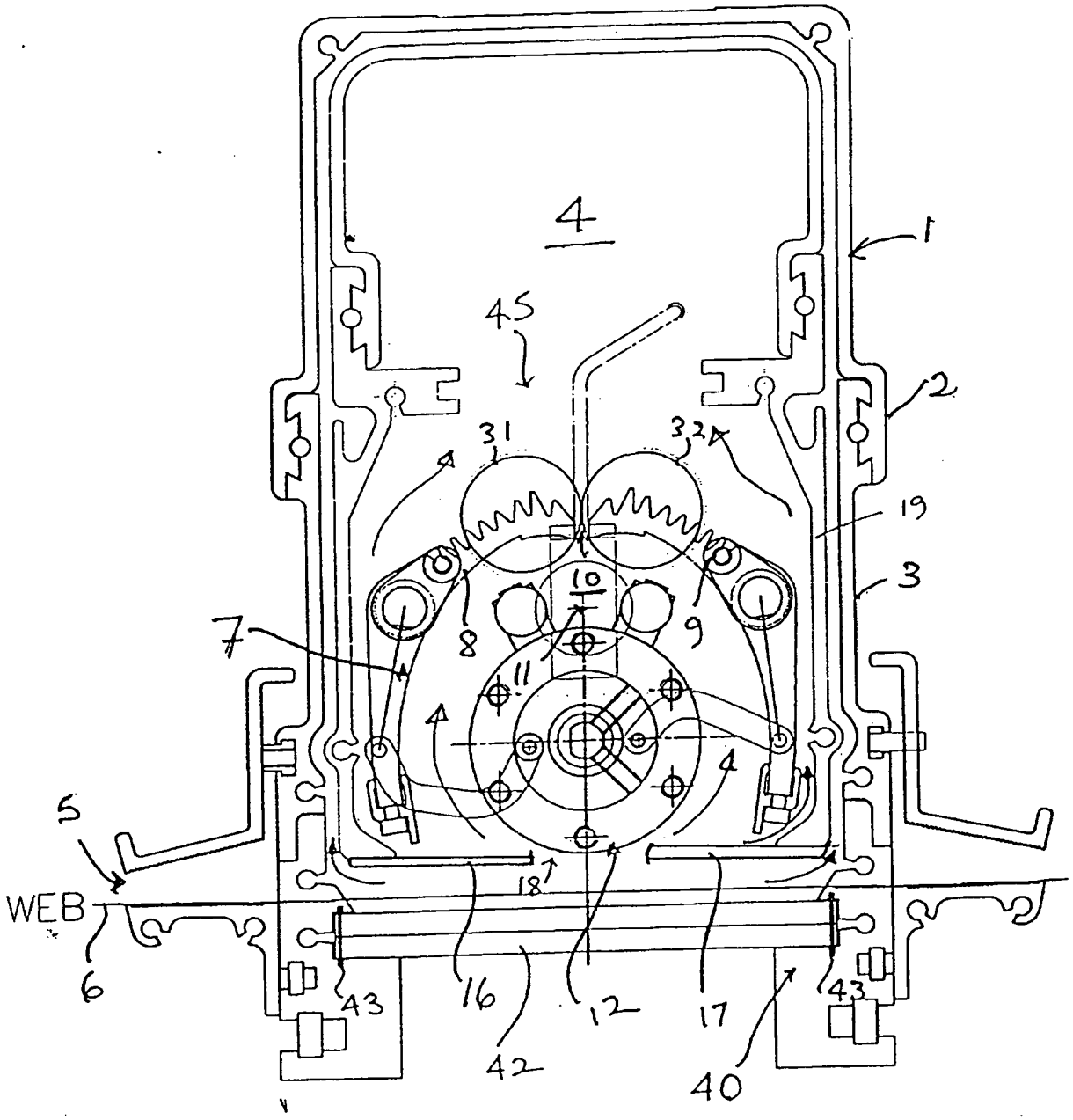
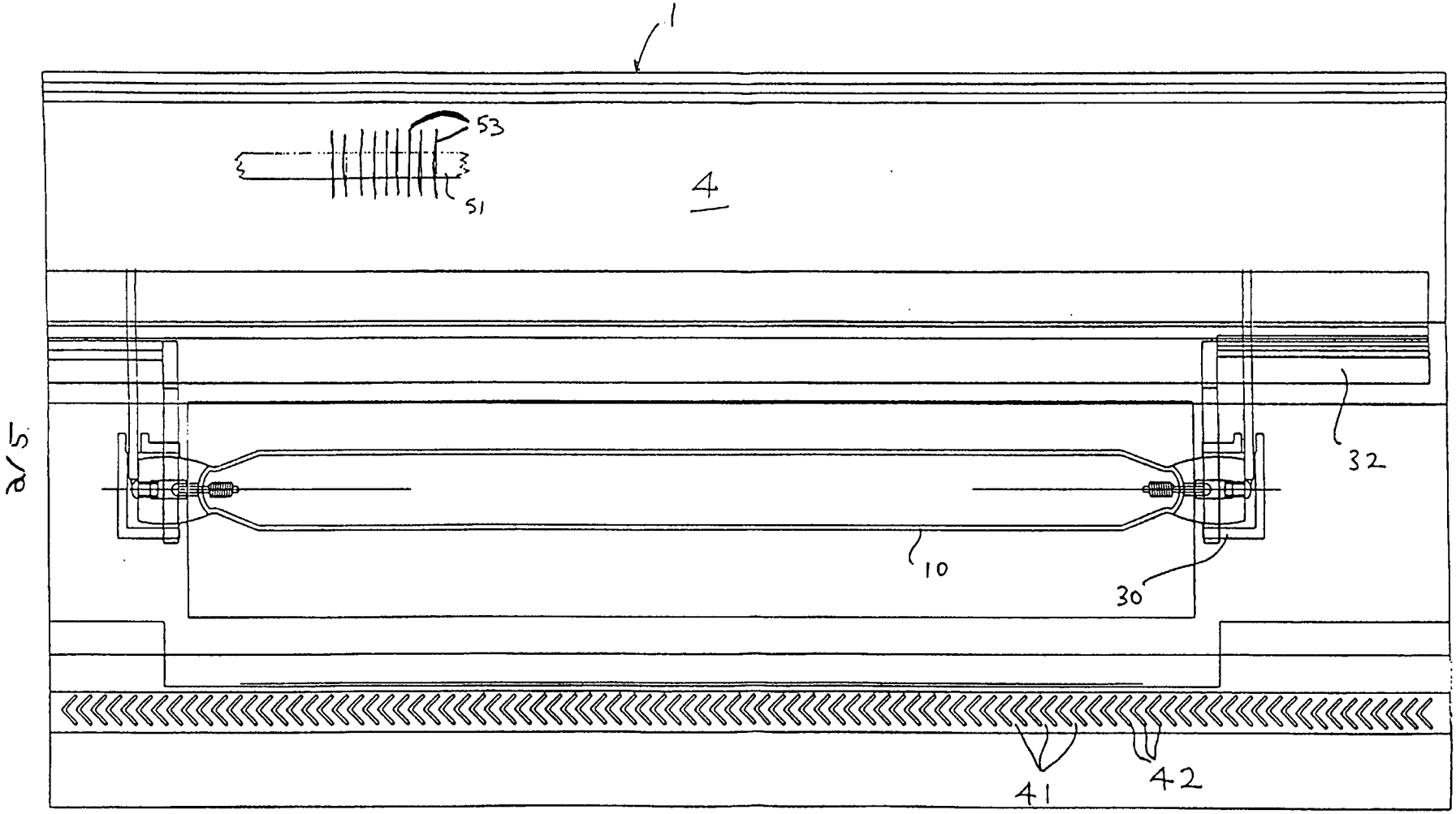


Fig 2



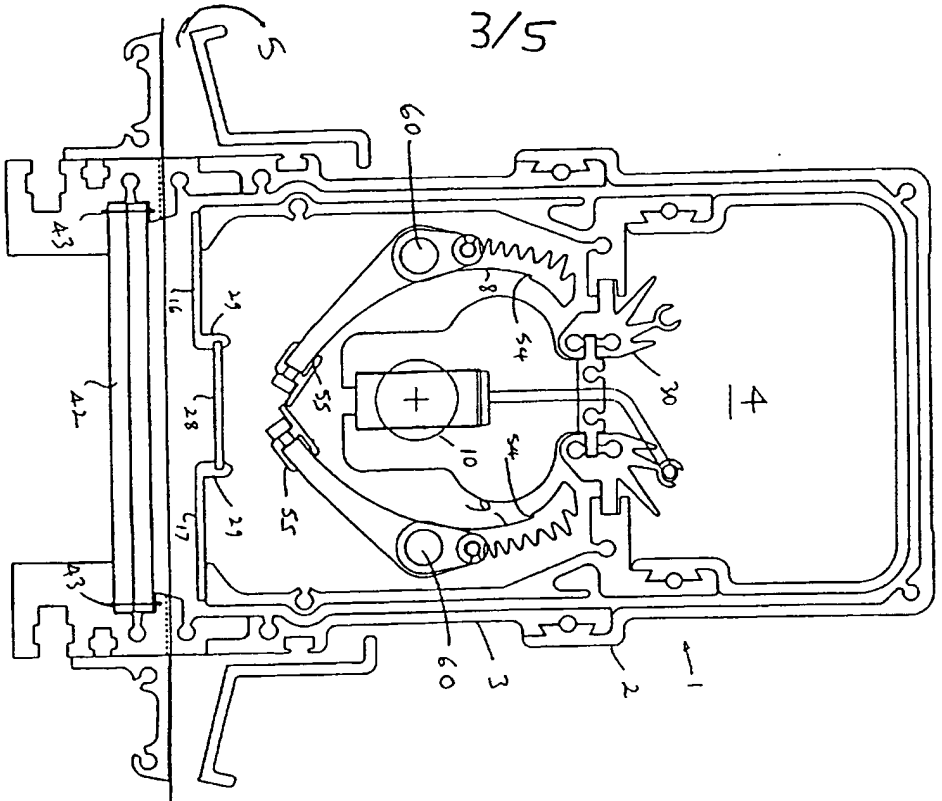

5
60
43
16
19
42
28
54
30
55
10
54
55
17
43
60
3
2
1
4

Fig 3

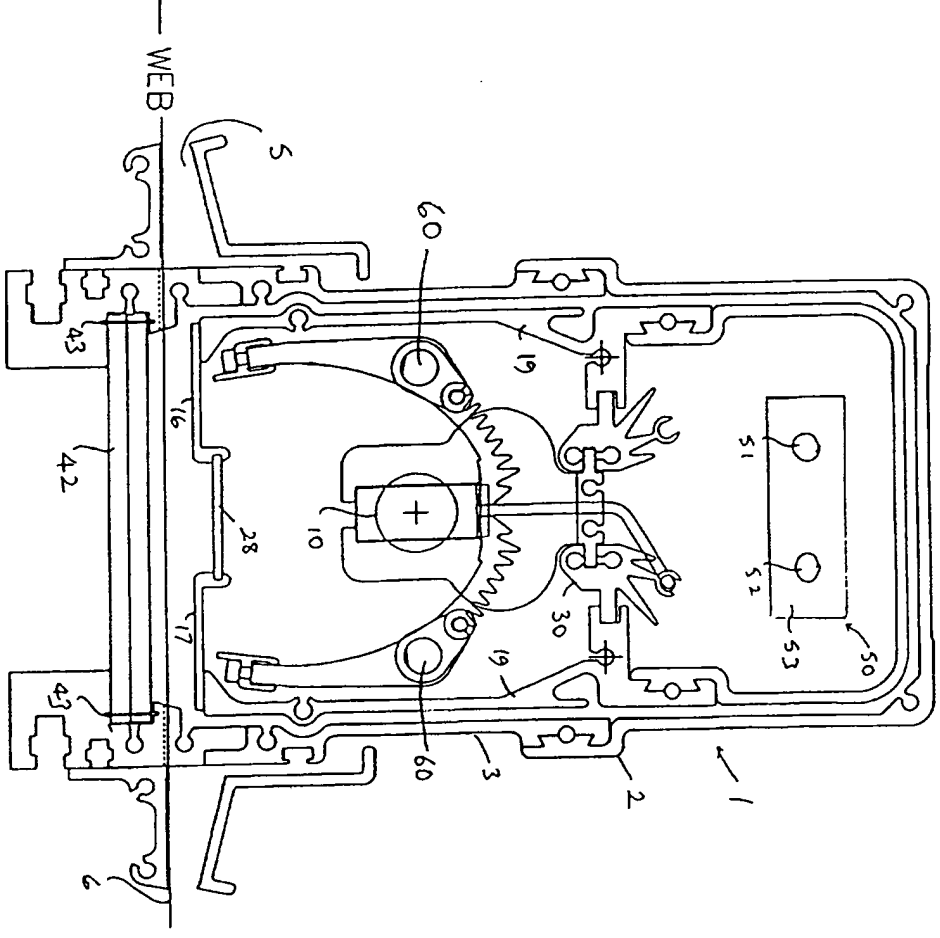

WEB
5
60
43
16
19
42
28
10
30
51
52
53
50
17
43
60
3
2
1
6

Fig 4

Fig 5

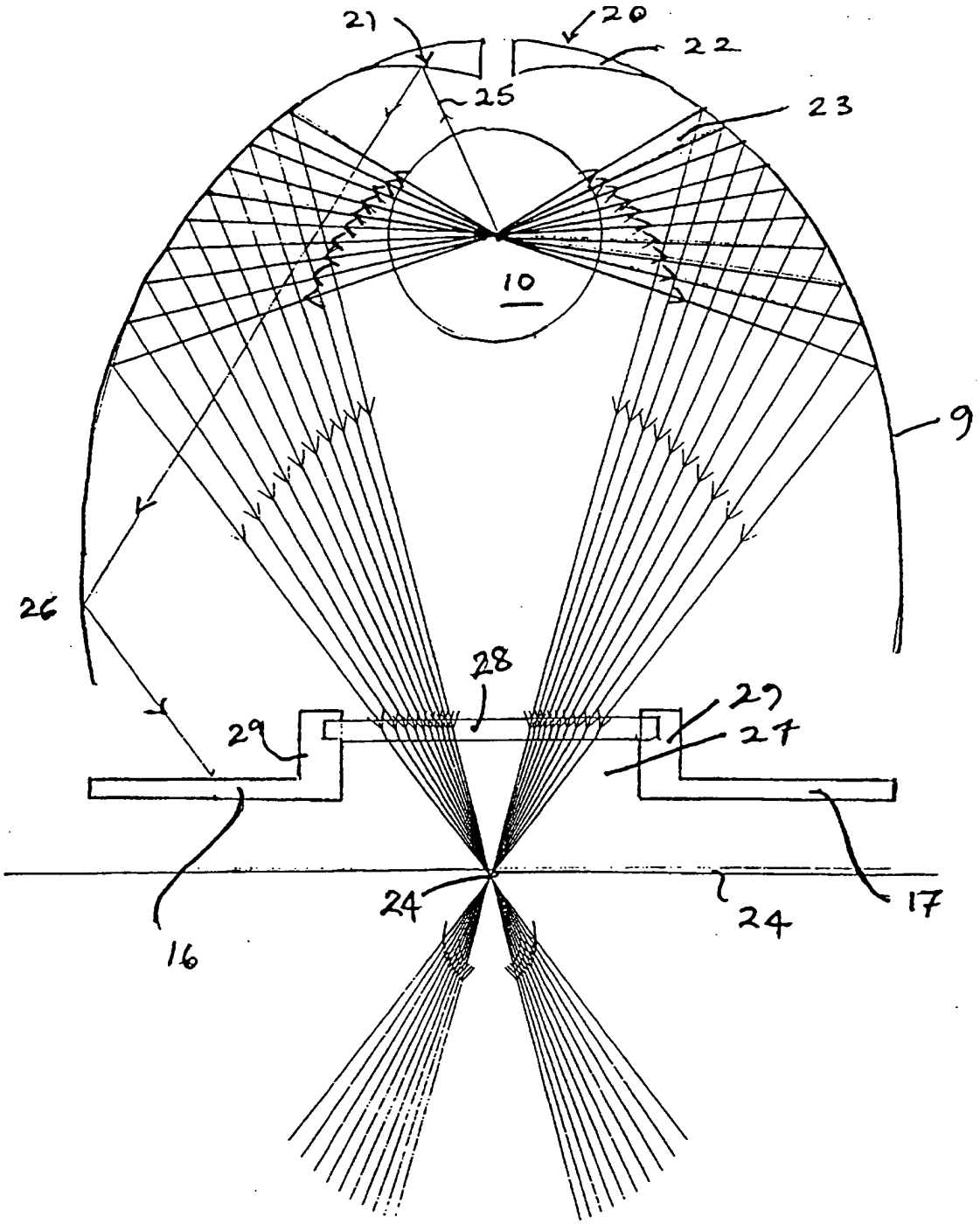


Fig 6(a)

Fig. 6(b)

Fig 6(c)

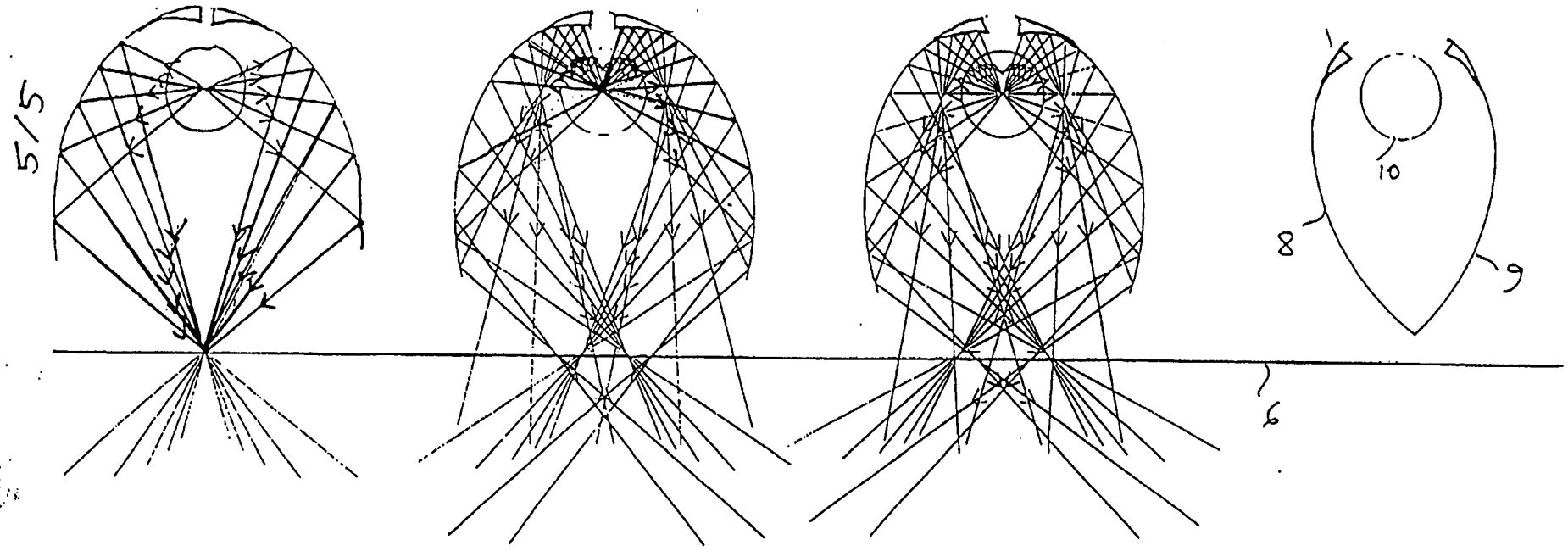
Fig 6(d)

SHUTTERS OPEN

5° SHUTTER MOVEMENT

10° SHUTTER MOVEMENT

SHUTTERS CLOSED



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UV DRYER WITH MOVEABLE REFLECTOR SURFACES

This invention relates to a UV dryer, particularly for printing inks and other UV photopolymerisable materials.

UV dryers are commonly used for the above purposes in which printed impressions supported on a continuous web are conducted past one or more UV dryers. In order to effect drying in the shortest time, it is desirable to concentrate UV radiation on the web as it passes a dryer. However, UV lamps commonly emit a significant amount of infra-red radiation which can cause distortion of the web or damage to the printed image, especially if the speed of the web is reduced or stops, even for a short time.

Another problem is that the life of UV lamps is reduced if they become overheated in use. It has been found by the present inventor that if radiation emitted from the lamp is reflected back through the lamp envelope, this will increase the temperature within the envelope and reduce the working life of the lamp.

The present invention is, therefore, directed to solutions to the above problems and generally to provide improvements in UV lamp design.

According to one aspect of the present invention, there is provided a UV dryer for drying printing inks and other photopolymerisable materials, wherein an elongated UV lamp is supported in a reflector housing for directing UV light onto a web conducted past said housing, the reflector housing supporting reflector surfaces which are generally elliptical in section but depart from a true ellipsoid in an apex region thereof, so that all light reflected by the reflector surfaces passes outside the envelope of the UV lamp.

The above situation can be achieved by modifying the reflector surfaces in the apex region. For example, these surfaces of the reflector can be arranged to be

profiled so that light rays received from the lamp are always reflected beyond the envelope.

The reflector housing may be provided with shutters of a generally bat-wing construction as described in WO 93/02329. However, preferably, the reflector surfaces are formed as moveable parts so that they can pivot between a first position at which light reflected from the reflector surfaces is focused on the web and a second position at which the reflector surfaces are interposed between the lamp and the web and thereby prevent radiation reaching the web. The reflector surfaces may, for example, be pivoted to their second position in the event that the web stops or moves only very slowly through the printing machine.

In one embodiment, the reflector surfaces may be pivotable in step-wise or progressive fashion in conjunction with the web speed, so that as the web speed reduces, the radiation projected onto the web becomes progressively less focused and may also be restricted to a progressively narrower slot.

The reflector housing may also be formed in the region of its mouth with one or more baffles extending from the sides of the reflector at its mouth, so as to reduce the amount of radiation reaching the web, which is received directly from the lamp. Radiation reaching the web directly from the lamp (i.e. without reflection from a reflector surface) will generally contain a higher IR component. A window may be interposed between the mouth of the reflector at the web in order to further reduce the amount of heat which reaches the web. By making the window from quartz, the UV light will pass through while the infra-red is blocked.

It is also a feature of the invention that the reflector surfaces are pivotable between the first and second positions by an operating mechanism comprising a rotary plate and link arms, each link arm serving to link a reflector surface to the plate so that rotation of the plate in one direction causes the reflector surfaces to pivot into the first

position, while rotation in the opposite direction causes the reflector surfaces to close towards one another.

In order to facilitate maintenance or replacement of the UV lamp, the lamp is preferably mounted on a carriage which is slidable longitudinally of the housing into and out of the housing for lamp replacement purposes. The carriage includes electrical connector components which mate with corresponding connector components located within the housing, when said carriage is slid fully into the housing. With this arrangement, the carriage can be quickly slid out from within the housing, perhaps after operating a quick disconnect latch, the lamp can then be changed and the carriage returned into the housing while reconnecting the connector components without requiring any adjustment to the electrical supply to the lamp.

Other features and advantages of the present invention will become apparent form the accompanying drawings, in which:-

Figure 1 is a transverse section through a UV dryer in accordance with the invention;

Figure 2 is a longitudinal section through the dryer shown in Figure 1;

Figures 3 and 4 are similar views to that shown in Figure 1, but taken at a different point along the lamp housing and show, respectively, the reflector surfaces in a fully closed position and in a fully opened position;

Figure 5 is a transverse view through the reflector showing diagrammatically the reflection of light from the reflector surfaces, and

Figures 6(a)-(d) show diagrammatically the reflection of light from the reflector surfaces at several stops between fully open and fully closed.

Referring to Figures 1 and 2, the dryer comprising a reflector housing 1 formed from upper and lower co-operating parts 2 and 3. The upper part of the housing provides a plenum chamber 4, through which cooling air is exhausted after passing

over surfaces of the lamp and the reflector. The plenum chamber 4 may be enlarged for higher output lamps or longer lamps by attaching a larger upper part 2 to the lower part of the housing. The lower part of the housing 3 includes a slot 5 through which a web 6 is conducted through the housing, and past a reflector assembly generally indicated at 7. The reflector assembly comprises a pair of reflector surfaces 8 and 9 which, together, form an elongated reflecting surface which is generally elliptical in cross-section.

Located at or near the focus of the elliptical reflector surfaces is a UV lamp 10 which, preferably, has an envelope which is transparent to UV and IR light so that filament 11 provides a line source of radiation. The reflector surfaces are pivotable between an open and a closed position, as shown in Figures 3 and 4. The reflector surfaces part and come together at the apex of the ellipse and are moved by an operating mechanism generally indicated at 12.

The operating mechanism comprises a rotary plate 13, having a pair of link arms 14 and 15, connected at one end to the plate and at the other end to a reflector surface. The arrangement is such that as the rotary plate rotates in one direction, the reflector surfaces are brought together and when rotated in the other direction, they move apart. The open mouth side of the reflector surfaces is partially closed by longitudinal plates 16 and 17 which form an elongated slot 18, through which UV light emitted from the lamp may reach the upper surface of the web.

As seen best in Figure 5, the reflector surfaces 8 and 9 are not a true ellipse in section but are flattened or part cylindrical in the apex region 20. These regions of the reflector surfaces 21 and 22 are preferably part cylindrical surfaces having a centre of curvature which is close to or outside the envelope of the lamp 10. This results in the situation that whereas a pencil of rays, for example 23, reaching the reflector surface 9 will be focused on the web at a point 24, a second pencil of rays 25 reflected from the

cylindrical surface 21, is reflected outside the lamp envelope and may strike the reflector surface 8 a second time at 26, at a point closer to the mouth of the reflector.

This light pencil 25 (and similar pencils of light radiation reflected from the parts of the mirror 21 and 22, are not focused on the web but may be scattered or reflected back into the area between the reflectors by plates 16 or 17. These plates may act as baffles or mirrors but generally their surfaces facing the lamp will be anodised black. There may be a gap 27 between the plates 16 and 17 to allow the focused light rays to pass. Alternatively, to further reduce the heat radiation reaching the web, this gap may be bridged with a window 28, such as quartz, which is transparent to UV light but opaque to IR radiation. Further heat protection for the web may be achieved by cooling the plates 16 and 17, either with air or with water. In the latter case, the plates may be formed with water cooling passages.

Direct cooling of the web is also highly desirable and this is provided by a heat sink 40, positioned just below the web. The heat sink may be a generally rectangular metal block which is cooled by water passed through passages formed in the block. Alternatively, the heat sink may be air cooled by air passed upwardly through slots 41 (see Figure 2) in the base of the heat sink. These are conveniently constructed from a series of metal strips 42 which are bent into a dogs' leg shape (to prevent radiation passing through the base of the heat sink), and located by longitudinal spacers 43. The base is conveniently assembled by pushing the ends of strips 42 into a pair of spacers 43, having a series of holes of the same shape as the cross-section of the strips, and sliding the spacers into corresponding recesses in the body of the heat sink 40.

Cooling of the dryer may be by air or water, or by a combination of the two. In general, air is used at least in part for cooling. Air is guided to pass into the lower part of the housing so that it flows over the inner and outer surfaces of the reflectors into the upper part of the housing. Air which flows over the inner surfaces of the

reflectors passes through the gap at the apex between the two reflectors and joins air which has passed over the backs of the reflectors. Some air may also pass between the inner and outer shells 1 and 19 of the housing, and is then directed away from one end of the housing. Flows of cooling air are shown by arrows in Figure 1. A gap 45 between the upper and lower parts of the housing is much larger in area than the gaps permitting air to enter the lower part of the housing. This leads to more uniform cooling of the lamp and improves its UV output. Also, the air flow into the lower part of the housing is generally transverse to the extent of the lamp and this improves uniformity of cooling along the lamp and avoids variations in UV output along the lamp.

Where a quartz window 28 (see Figures 3, 4 & 5) is positioned between baffles or mirrors 16 and 17, the supporting flanges 29 may have apertures (or be castellated when seen in longitudinal elevation), to permit entry of cooling air to flow into the lamp housing from below.

Particularly, in cases where the upper part of the lamp housing is extended upwardly, this may contain a heat exchanger 50. This is shown diagrammatically in Figures 2 and 4, in which one or more pipes 51,52 for cooling water carry a plurality of vanes 53. Air is cooled by passage over the vanes and around the pipes after it has passed around the lamp and reflectors, and is then sucked out of the upper part of the lamp housing. This arrangement has the advantage that ducting pipes for air from the dryer need not be insulated and that, being cooler and hence denser, a larger mass of air will be drawn through the housing for a given extraction fan speed, resulting in greater efficiency and lower power consumption.

As can be seen in Figures 1, 3 and 4, the reflector blades are finned on their back surface only at the portions close to the apex of the reflector. This is because the parts of the blades which are truly elliptical are protected by the dichroic filters

(described above) and thus do not heat so rapidly. The reflector blades can also be cooled by passing water through the pivot points 60.

Light which is reflected from a surface of the reflectors, will generally have a lower IR content, at least partly because the surfaces of the reflector are covered with dichroic filter surfaces. Dichroic filters are substantially transparent to infra-red light but reflect UV light. The construction, location and fitting of such dichroic filters is described in our co-pending application PCT/GB97/00940, the contents of which are incorporated herein. Preferably, the dichroic filters are films deposited on flexible metal strips and then fitted to the reflector surfaces 8 & 9. The metal strips carrying the dichroic films are fixed to the surfaces of the reflector blades by engaging one end of a strip in a recess 54 (see Figure 3) and clamping the other end by means of a clamp 55.

The lamp 10 is mounted on a carriage 30 (seen best in Figures 3 & 4), which slidably engages with the interior surface of an internal shell part 19 of the housing 1 and can be removed from one end of the housing, e.g. by opening a latch securing the carriage within the housing. Connector parts 31,32 are mounted at one end of the housing and connect with corresponding connector parts on the carriage so that the lamp is automatically connected to the electrical power source as it is introduced into the housing.

Figures 6(a)~(d) illustrate the effect of closing the reflector blades in a step-wise manner. Figure 6(a) corresponds with the position in Figure 5 wherein the light is essentially focused in a central line on the web. In Figure 6(b), the blades have been opened by only 5° but it can be seen that the light has been de-focused. After a further 5° movement, light has been spread over a wider band. This progressive de-focusing means that the average intensity of light at a given line on the web is gradually reduced.

Preferably, the operating mechanism for the reflector surfaces includes control means linking the speed of the web to the operating mechanism, in such a way that reduction in the speed of the web below a predetermined value causes the reflector surfaces to pivot progressively from a first position to a second position. In the first position, light is focused onto the web and in the second position, the reflector surfaces are interposed between the lamp and the web so that no light may reach the web.

Preferably, the control system causes the pivoting to be progressive from the first and second positions in inverse proportion to the speed of the web, whereby the reflected light is progressively defocused.

In practice, the lamp output will be reduced initially as the web speed falls, while maintaining the reflectors in the first position as shown in Figure 4. Normally, only after the lamp output has been reduced to about 40% of maximum power, will the reflectors start to move towards the second position so as to progressively defocus the UV beam directed onto the more slowly moving web.

Most printing machines incorporate a tachometer or other speed indicator which generates an electrical signal, such as a voltage or series of pulses, the value or frequency of which is indicative of the speed of the web.

In accordance with another aspect of this invention, the electrical signal from the web tachometer can be used directly to control the movement of the reflectors towards the second position shown in Figure 3. The output signal from the tachometer may also simultaneously be used to control the output from the lamp so that the as the speed reduces, the output of the lamp is simultaneously reduced to a minimum setting of 40% of the maximum output of the lamp. Reduction of the operating output of the lamp can be controlled, e.g. by thyristor control of the

electrical supply to the lamp in accordance with a corresponding reduction in the speed of the web.

During the phase from 100% lamp output down to 40% output, the reflectors may be controlled to remain in the first position, but as the speed of the web drops below a speed at which a 40% output would cause excessive heating of the web, the reflectors begin to move towards the second position. This movement can be arranged to be stepwise in one or more steps or, alternatively, arranged to be a continuous movement.

CLAIMS:-

1. A UV dryer for drying printing inks and other photopolymerisable materials, wherein an elongated UV lamp is supported in a reflector housing for directing UV light onto a web conducted past said housing, the reflector housing supporting reflector surfaces which are generally elliptical in section but depart from a true ellipsoid in an apex region thereof, so that all light reflected by the reflector surfaces passes outside the envelope of the UV lamp.

2. A dryer as claimed in claim 1 wherein the reflector surface is formed in movable parts which are pivotable between a first position at which light reflected from the web is focused on the web and a second position at which the reflector surfaces are interposed between the lamp and the web.

3. A dryer as claimed in claim 2 wherein the reflector surfaces are pivotable between first and second positions by an operating mechanism comprising a rotary plate and link arms each linking a reflector surface to the plate so that rotation of the plate in one direction causes the reflector surfaces to pivot into the first position, while rotation in the opposite direction causes the reflector surfaces to close towards one another.

4. A dryer as claimed in claim 3 which includes control means linking the speed of the web to the operating mechanism for said reflector surfaces, wherein reduction of the speed of the web below a predetermined value causes the reflector surfaces to pivot progressively from said first position to said second position in inverse proportion to the speed of the web, whereby the reflected light is progressively defocused.

5. A dryer as claimed in any one of the preceding claims wherein the lamp is mounted on a carriage which is slidable longitudinally of the housing into and out of the housing for lamp replacement purposes, the carriage including electrical connector components which mate with corresponding connector components located within the housing when said carriage is slid fully into the housing.